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8. Insects of the Field.

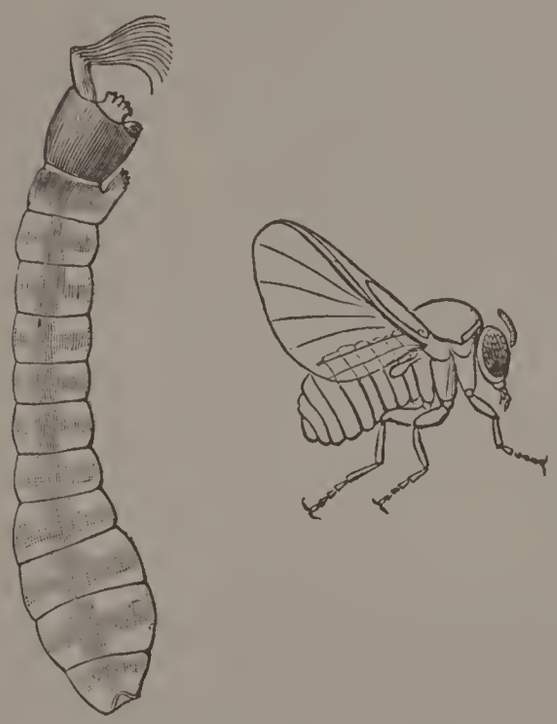
WE will now step from under the shade of the apple trees, and walk out in the open fields. And here the bustle and stir of insect life is as bewildering and overpowering to him of acute entomological sense as a walk down Broadway or along the Strand is to the rustic. Insects love the open fields. Under the shade of the forests they pursue their avocations in comparative silence; in the garden or orchard their limbs are cramped, and their gluttonous life may be accounted for in part by their sedentary habits. There they eat, drink, and sleep, and that is with them the end of their existence; but for merry making, hilarity, and a busy metropolitan industry, which shows an interest in all insect-kind, all the while intent on their own life work, and for light-hearted enjoyment of the blessings of an open sky, the breezy sod, and freedom of the grassy plains, commend us to the insects of the fields. And by fields we mean not the broad prairies or dreary moors, but the savannas and glades in forests, the lawns bordered with the hawthorn, buckthorn or cedar, and the grass lands, and wheat and corn fields.

The bees with their swift, strong, steady flight and busy hum, the grasshopper with his sprightly leap and laughing chirrup, the gorgeous butterfly floating aloft, clearing an acre in one swoop, these are the true field insects; while, envious of their active life, the noisy Cicada leaves his forest shelter and clinging to some shrub in the open field swells the chorus of insect sounds with his rattling, shrill cry.

There is really a distinct assemblage of insects peopling the fields. At the suggestion of a walk out into the open country we have visions of grasshoppers rising under our

feet in swarms, and describing, like fire works, radii of circles centring at our feet; the crickets, whose wings had been rasping their love notes, or rather, chirrups, close them tightly over their backs, and run, like so many quail, from one grassy covert to another. We always expect to find certain moths hidden in the grass of the lawn or hay field, which, startled at our approach, rise and wildly fly off in their headlong course to a fresh hiding place; and by the roadside, swarms of the yellow Colias alighting at some pool to quench their thirst. The mosquitoes we scarcely expect to find on the breezy plains. The still forest, the darker and damper the better, is their home. Favoring winds support their halting flight and bear them to our houses. On the other hand the Black fly (Fig. 142) and midge are only found on the edges of woods, in open fields and on the bare hill tops. A hundred bees may be seen in clover fields to one in the woods, the flowers attracting them rarely growing there. The Hessian fly hovers in swarms over wheat fields. The ant loves the roadside and the open glades in forests, and the wasps, when they do nest in the woods, prefer places where the scattered trees seem endeavoring to break away from the restraints of the woodland.

FIG. 142.



Black Fly and young, enlarged.

The insects of the field come and go with the changes of the season. Troops of moths fly about in the grass lands in May, and desert the fields during June and July, until August ushers in fresh hordes, whose highly colored, brightly

marked wings prove their recent exclusion from the chrysalis. The months of May and June are signalized by the appearance in great force of the geometrid moths (Figs. 143, 144*). They disappear from the fields in July, when swarms of owlet moths (Fig. 145) take their places, and in August others, such as the Agrotis (Fig. 146) and Plusia

FIG. 143.

Endropia.

FIG. 144.

Phasiane.

(Fig. 147), which, as the name of the latter indicates, is rich in the possession of gold and silver spots on its wings; visit in the bright sunshine the flowers of the golden rod and the aster, busily engaged in collecting pollen, and unconscious agents in fertilizing the flowers of these showy plants, which do little harm, but in early autumn impart a gay, rich color

FIG. 145.

Owlet Moth (Cucullia), after Lintner.

to our sombre fields; and thus in more ways than one these insects of the field cheer up the melancholy days of autumn. The generation of moths is maintained late in September by the delicate Chain moth (Fig. 148, *Zerene catenaria* and larva) which flutters over the golden rods and sweet fern;

* From Hayden's Report on the Geology, etc., of the U. S. Territories.

while later still in warm days in November and sometimes every winter month, and in early, preternaturally warm spring days, the male canker worm flutters helplessly about our orchards and fences. The tiger beetles (Cicindela; Fig. 149, *C. sex-guttata*) are essentially field insects, loving the sandy banks of streams, the roadside and sunny paths; and the different months of spring and summer witness the arrival of different species.

FIG. 146.

Agrotis.

FIG. 147.

Plusia.

When a tree is separated from its fellows and left standing in a field, it becomes the centre of attack of many different varieties of insects. If an oak its twigs are hung with countless galls, the flies assembling year after year stinging the leaves and branches as surely as the season comes around. The same kind of caterpillars annually receive their tribute of leaves, and the

FIG. 148.

Chain moth and caterpillar.

symmetry of the oak is maintained by the judicious pruning of boring beetles and other insects, while its boughs afford rest and shelter to the birds, which in their turn judiciously check the too great increase of the insect plunderers, and instal a reign of conservative agencies which maintain the oak in its pristine vigor and hands it down from generation to generation of landed proprietors. The growth and maintenance of field crops are almost wholly regulated by the

insects, now that the birds are not allowed a fair chance of restraining the undue increase of these pests. Our potato crops are becoming dependent on the number of insects rather than the excellence of artificial fertilizers; we may top-dress our wheat fields, and till the soil never so sedulously, but the fact is well known that the wheat crop in the eastern states is nearly cut off by the Hessian fly, the wheat midge, and the joint worm. Our corn fields in the far West are dependent on the will of the grasshopper and the chinch bug. The losses annually sustained by the assaults of the armies of injurious insects are almost beyond calculation, and so quietly and neatly is the work done, that few are the farmers who realize the extent of the loss and how it has been effected. Not until they study the daily life of these insects and watch them by day and night, and know something of their life history; until they recognize the fact that as caterpillars and chrysalides and winged insects they lead different lives, have quite different means of livelihood, can they appreciate the extent of the powers for mischief in the little beings they trample on unconsciously or in contempt.

FIG. 149.

Tiger beetle.

What meaning is there in the bustle and hum of insect life, to which the ears of most of us are deaf? The only way to answer this question is to sit down for oneself and watch the daily doings of some one insect and make a record of them, by which others may profit. The busiest man can devote a few minutes each day to a study of the common insects that enter his window or visit the flowers in his garden. He can readily train the ladies of the household, or the children, to aid in the work of observation, and by thus combining the aid of several observers, test their several results. All this does not require a scientific knowledge of the anatomy and physiology of these creatures; only a little patience and interest in the subject of inquiry. An

example of what one may do whose time is occupied with multifarious duties is afforded by the results obtained by Sir John Lubbock, and published in a paper entitled "Observations on Bees and Wasps," read at a late (1874) meeting of the Linnæan Society of London. In order to ascertain how a honey bee fills out the measure of a day he kept some bees in a hive in his room, and marked some of them and watched their goings in and out. A bee between 7 A.M. and 12.52 P.M. made twenty-three visits from the hive to the honey. During an hour and twenty minutes of this time access to the honey was cut off. Another bee between 7.23 A.M. and 12.51 P.M. made nineteen visits to the honey, the door being closed for thirty minutes of the time. Still another bee, between 9.19 A.M. and 1:54 P.M., made twenty visits to the honey. Other data are given, showing the close application of these bees to their business, and that the popular notions as to their busy ways are well founded. They apparently work after noon as well as before noon. One of Lubbock's marked bees made twenty-eight visits between 12.15 P.M. and 6.14 P.M. Similar experiments made on wasps (Fig. 150, white-faced wasp) show that they emulate the busy ways of their cousins, the bees. Indeed, it is perhaps not too rash a conclusion to draw from these and observations on other insects that a ceaseless activity pervades the members of the republic of insects; and that their moments of rest only result in still greater activity.

FIG. 150.

White-faced Wasp.

Were it not for this unremitting toil in providing for the welfare of their progeny, which in bees, especially, consists in extracting honey from flowers, many species of plants would become extinct. Nay, it is safe to state that many

kinds of plants would never have been brought into existence at all had it not been through the modifying influence of bees and moths. The interdependence of insects and plants lately shown to exist by various observers is one of the most striking in nature. Many gardeners are aware that bees aid greatly in the fertilization of the flowers of the melon, cucumber and squash by conveying the pollen of one flower to another and to those of adjoining gardens. This ensures the production of fruit, where otherwise many a flower would be barren. It is known that a larger crop of apples is raised when a hive of bees is stationed in the orchard. The bees visit every flower, busily flying from one to another, and then passing to an adjoining tree. Their bodies dusted over with the pollen rub against the pistils of hundreds of flowers, which thus become fertilized. In the same manner the moths, bobbing their heads into the tubular flowers of the orchids and other plants, probe them with their long tongues, and withdraw them with a packet of pollen attached, which they leave on the pistil of some other plant. In this way the plant maintains its existence; and there is no deterioration in the stock, since the pollen is conveyed from plants afar off by the bees, and too close in-and-in breeding, a thing nature abhors, is prevented. Now this sort of work is going on far more extensively than was suspected before Mr. Darwin called the attention of naturalists to the matter. It seems, from the studies of Sprengel, Darwin, Hermann Müller, and others, that on the other hand many of the strange modifications in the form of flowers are due to insects. Not only are changes in form produced by the different kinds of insects and their varying mouth-parts, but it has been boldly suggested* that originally the scent and color and even the honey of flowers are due to the influence of insects. On the other hand any one

*"On British Wild Flowers considered in Relation to Insects." By Sir John Lubbock. Macmillan & Co. 1875.

by reading the admirably lucid statements of Müller and Lubbock can for himself realize how dependent the form of the insect, particularly the form of the mouth-parts and legs, are on the form of the flower. As Lubbock remarks, "there has thus been an interaction of insects upon flowers, and of flowers upon insects, resulting in the gradual modification of both."

The transfer of pollen from plants of different varieties or species results in hybrids which are much larger than the original forms. Cross fertilization, as this is called, is an advantage to the plant, and is resorted to constantly, as every body knows, by horticulturists. Lubbock quotes Darwin's remark that "all experimenters have been struck with the wonderful vigour, height, size, tenacity of life, precocity and hardiness of their hybrid productions." Mr. Darwin was the first to show that if a flower be fertilized by pollen from a different plant, the seedlings so produced are much stronger than if the plant be fertilized by its own pollen. Lubbock, from whom we take this statement, saw these experiments of Mr. Darwin, and remarks that the difference was most striking. "It is, moreover, remarkable that in many cases plants are themselves more fertile if supplied with pollen from a different flower, a different variety, or even, as it would appear in some instances (in the passion flower, for example), from a different species. Nay, in some cases pollen has no effect whatever unless transferred to a different flower. Fritz Müller has recorded some species in which pollen, if placed on the stigma of the same flower, has not only no more effect than so much inorganic dust, but, which is perhaps even more extraordinary, in others, he states that the pollen placed on the stigma of its own flower acted on it like a poison. This he noticed in several species; the flower faded and fell off; the pollen grains themselves and the stigma in contact with them, shrivelled up, turned brown, and decayed; while other flowers on the

same branch, which were not so treated, retained their freshness." Now, as we have said, the great agencies in nature in performing this act of cross fertilization are the wind and insects, principally the latter. The stamens and pistils of the pines, birches, poplars, grasses, corn and other cereals are so arranged that the wind fertilizes them, but in a large number of flowers the stamens are so situated in relation to the pistils, that the ovule in the latter can only be fertilized by the agency of insects. For this end the plant must hold out some inducement to the bees and moths, in order to attract them, something besides bright colors and sweet smells, which are known to attract insects. "Flowers, however sweet-smelling or beautiful, would not be visited by insects unless they had some inducements more substantial to offer. These advantages are the pollen and the honey; although it has been suggested that some flowers beguile insects by holding out the expectation of honey which does not really exist, just as some animals repel their enemies by resembling other species which are either dangerous or disagreeable."

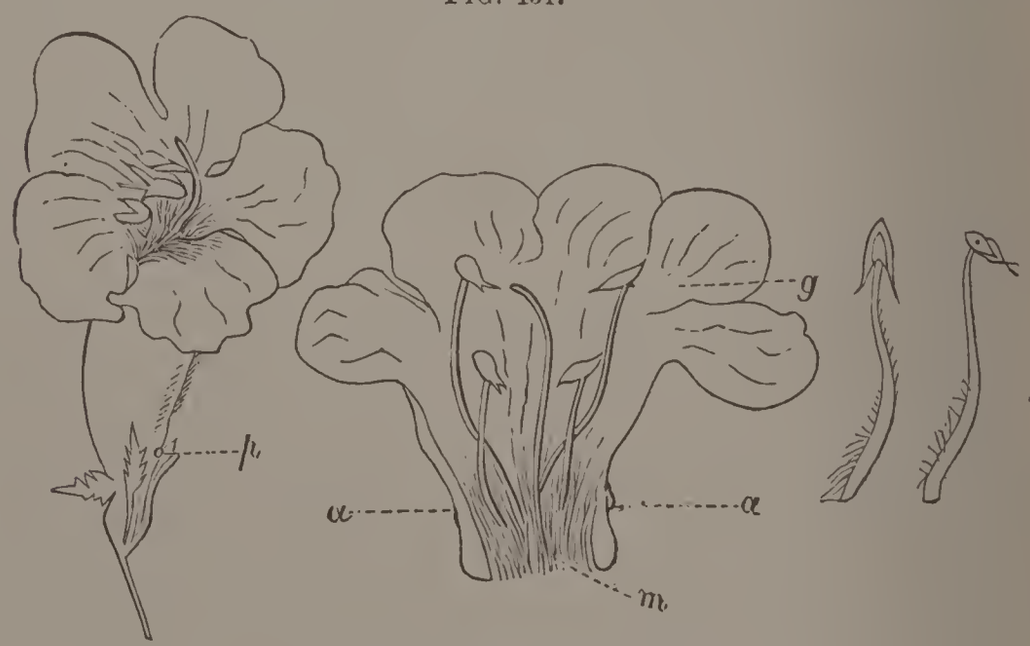
That many insects are attracted by smells we well know, but Lubbock has been the first to show that bees and wasps are attracted by and can distinguish colors. "I placed," he says, "slips of glass with honey, on paper of various colours, accustoming different bees to visit special colours, and when they had made a few visits to honey on paper of a particular colour, I found that if the papers were transposed the bees followed the colour."

The bright streaks of different hues which adorn the petals of flowers serve the most utilitarian purpose; namely, as guiding lines to show the bee the way down to the deposit of honey. At figure 151, *g* indicates the bright colored guiding lines which lead down to the nectary. Lubbock remarks that he did not realize the importance of these guiding lines until, by experiments on bees, he saw how

much time they lose if honey, which is put out for them, is moved even slightly from its usual place. With good reason, therefore, he adopts Sprengel's suggestion that the lines and bands by which so many flowers are ornamented have reference to the position of the honey. Lubbock observes that these honey guides are absent in night flowers, where of course they would not be visible, and would therefore be useless, as for instance in certain English flowers, as *Lychnis vespertina* or *Silene nutans;* it is a curious fact that the former flower is white, while *Lychnis diurna*, which flowers by day, is red.

In some cases bees, baffled in their attempts to find the honey, take a short cut and perforate the corolla with their jaws. The first and only instance yet known of this curious

FIG. 151.



Gerardia perforated by bees.

trait in this country is that given by Mr. W. W. Bailey in the "American Naturalist," 1873. He noticed that the flowers of *Gerardia pedicularia* were perforated by the bees at the point indicated by *p* in figure 151 (also seen at *a*, where the corolla is split open). Mr. Bailey writes, "I have seen bees approach the front for a moment and then retire

as if baffled. Most of them, however, begin operations at the back at once. They alight with the tail towards the open end of the flower, and at once insert the head into the little hole. I have never seen them make the aperture, although it is difficult to find a blossom without one. Even the buds are often penetrated; out of a large number of flowers plucked at random from different plants in different localities I cannot find one flower without the slit." The bees alluded to were humble bees. In Europe they are known to perforate the flowers of the bean and similar plants.

Lubbock, in concluding a chapter on the importance of insects to flowers, says that to insects "flowers are indebted for their scent and colour; nay, for their very existence, in their present form. Not only have the present shape and outlines, the brilliant colours, the sweet scent, and the honey of flowers been gradually developed through the unconscious selection exercised by insects; but the very arrangement of the colours, the circular bands and radiating lines, the form, size, and position of the petals, the relative situations of the stamens and pistil, are all arranged with reference to the visits of insects, and in such a manner as to insure the grand object which these visits are destined to effect."

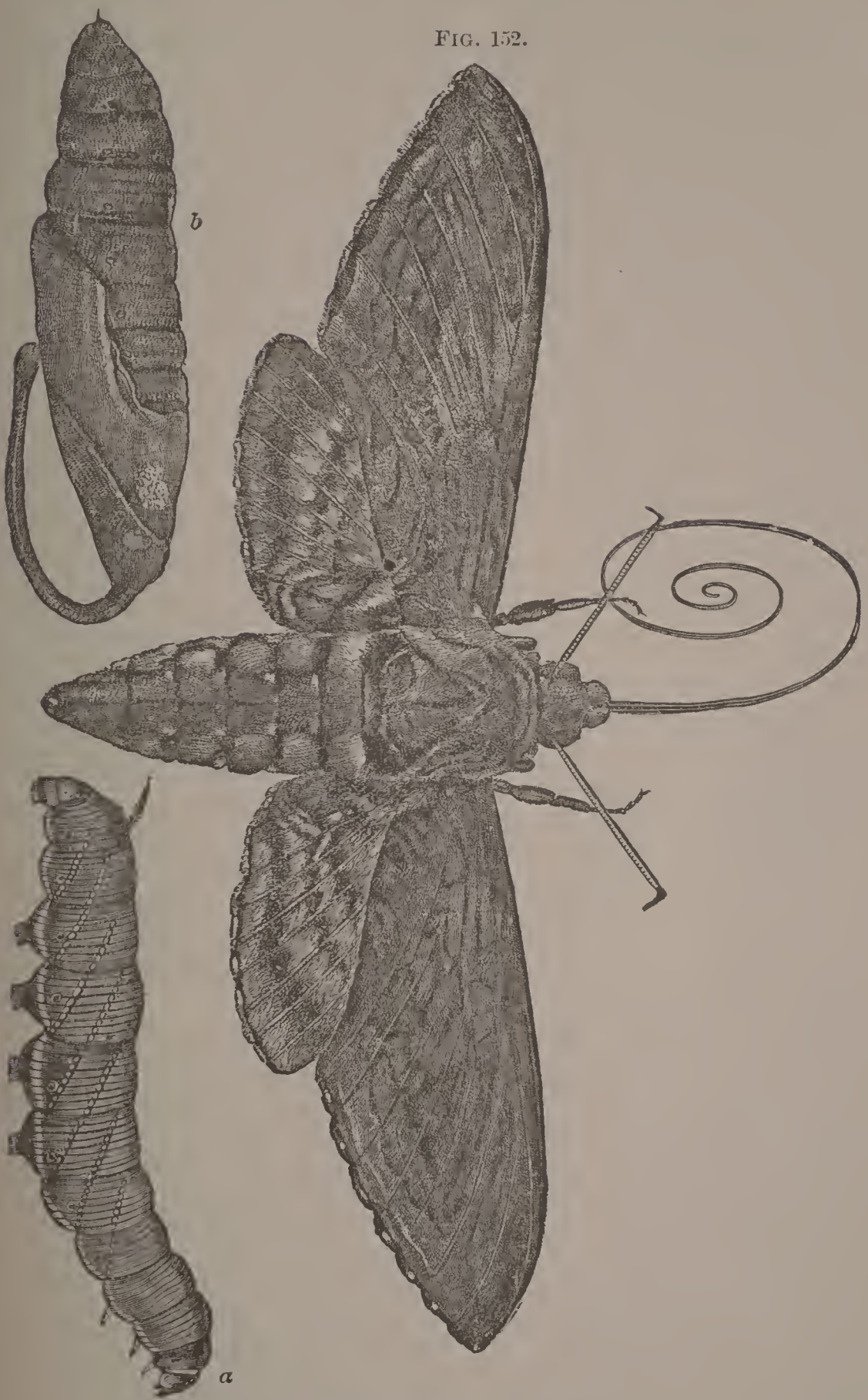
It will be seen from these facts and suggestions that the distribution of insects depends largely on that of plants. A field of clover will attract humble bees for miles around; the night flying moths are attracted long distances to those flowers which are open at dusk, at night or in the early morning, such as the honeysuckles, pinks, scarlet runners, petunias, and other tubular flowers. Indeed, Lubbock remarks in this connection that "flowers which are fertilized by night-flying insects would derive no advantage from being open by day; and on the other hand, that those which are fertilized by bees would gain nothing by being open at night. Nay, it would be a distinct disadvantage, because it would render them liable to be robbed of their honey and pollen, by in-

sects which are not capable of fertilizing them. I would venture to suggest, then, that the closing of flowers may have reference to the habits of insects, and it may be observed also in support of this that wind-fertilized flowers do not sleep; and that some of those flowers which attract insects by smell, emit their scent at particular hours; thus *Hesperis matronalis* and *Lychnis vespertina* smell in the evening, and *Orchis bifolia* is particularly sweet at night."

The tongue of the hawk moth is often of great length, adapting it for probing the deep corollas of various orchids, etc. For example, the tongue of the moth of the tobacco worm (Fig. 152; *a*, caterpillar; *b*, chrysalis with its large tongue case reaching to the middle of the body) is very long, but still moderate in its proportions compared to that of a Madagascar species in which it attains a length of nine and a quarter inches, and as there are said to be orchids with flowers as deep as this, there is evidently a relation of cause and effect between the two facts. Some moths, such as the silk worm moths, have the tongue undeveloped and they are not known to visit flowers. Other modifications in the palpi and legs of insects are correlated with the different methods insects take to collect and bear away pollen and honey.

It is a significant fact, which has been alluded to by authors, that in the arctic regions many flowers are wanting, which elsewhere are fertilized by insects also absent from circumpolar lands. If plants were introduced they would become extinct, possibly not on account of the severity of the climate, but because there would be no insects to render the flowers fertile and capable of producing seeds. The advent of many, if not nearly all the flowering plants in past geological periods undoubtedly went hand in hand with the appearance of insects. Now the bees and moths and butterflies, particularly the bees, are among the most highly developed of insects, and were the last to appear in the later geological periods. What a striking exemplification of the

FIG. 152.



The Tobacco Worm, Chrysalis and Moth.

harmonies of nature, this coeval birth of flowers and insects, each modifying the other; new forms of animals giving rise to new floral creations!

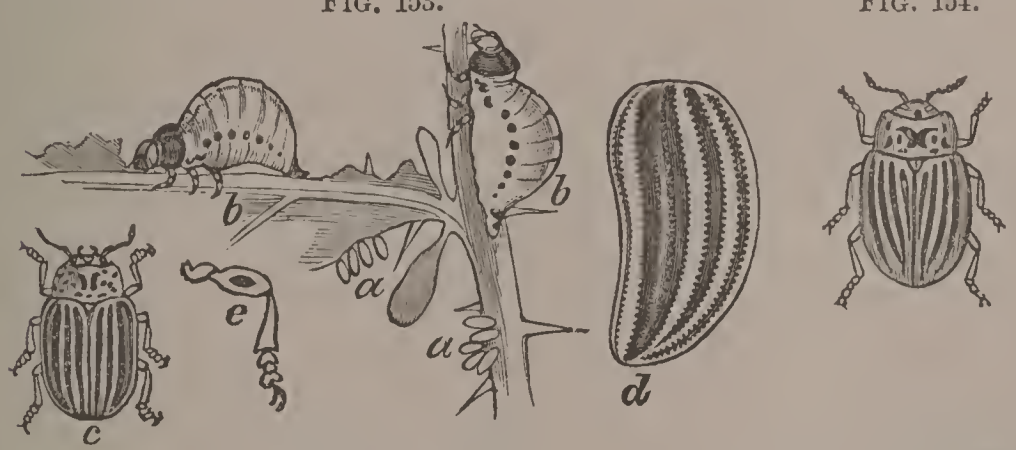
But in this utilitarian age and country it will not do to speak of field insects without mentioning those which ravage our field crops, as well as those which aid in producing them. Perhaps no insect in this country, except the cotton worm, has carried more consternation among farmers than the plump-bodied, phlegmatic, well-to-do looking beetle, which from living a quiet, harmless life on the wild, useless species of Solanum in the valleys at the base of the Rocky Mountains, has suddenly invaded our potato fields and robbed our farmers of hundreds of thousands of dollars' worth of this important crop. Not a European importation, this insect has made its home in a region of our country differing far more in its physical and climatic features from its native territory than does Europe from the northeastern states. It is an example, to use the language of the botanists, of a *prepotent* insect, which, like a weed when introduced into a new country, increases far more rapidly than at home, and crowds out the native insects, asserting itself everywhere in our farms and highways and byways.

Mr. B. D. Walsh, late state entomologist of Illinois, has given us an interesting history, in the "Practical Entomologist," of the first appearance of this insect. He shows that the original home of this beetle was in the valleys of the Rocky Mountains in Colorado Territory, where for nearly fifty years it has been known to feed upon a wild species of potato (*Solanum rostratum*). When these valleys became settled and the potato planted there, this beetle adopted it as its food, and then began a new chapter in its history. It should be remembered that the potato is also a species of Solanum, and the change in the nature of the beetle's food not great. By 1859 it had spread eastward to within a hundred miles of Omaha, Nebraska. In 1861 it

passed into Iowa, and in 1864 and 1865 it crossed the Mississippi, a thing which never ought to have been allowed. It invaded Illinois on its western border, crossing over from northeastern Missouri and Iowa. Mr. Walsh predicted that it would advance eastward at the rate of fifty miles a year. In 1868 it appeared in Ohio. Mr. Riley states that its average annual progress towards the east has been upwards of seventy miles. "At the same rate of progression it will touch the Atlantic Ocean in about ten years from now, or A. D. 1878."* But in fact it has travelled faster than that, and the year 1876 will witness the arrival of this pilgrim from the west in the potato patches of the descendants of the Pilgrim Fathers.

This beetle belongs to the family of leaf-eating Coleoptera (or Chrysomelidæ) of which the common striped squash

FIG. 153. FIG. 154.



Doryphora juncta. D. 10-lineata.

beetle is a familiar example. It lays its eggs on the leaves of the plant it inhabits in the larva, or grub, and the adult state; while in the pupal, or inactive, period of its existence it lives in the ground, just under the surface of the soil. Figure 153, from Riley, gives an idea of *Doryphora juncta*, an ally of this insect, in its different stages. All the drawings are of the size of life except *d*, a wing cover, and *e*, representing a leg enlarged; *a* represents the yellowish

*First Annual Report on the Noxious and Beneficial Insects of Missouri, 1869. p. 102.

eggs; *b*, larva fully grown and soon after hatching; *c*, the beetle itself, which is cream-colored, with three black stripes on each wing cover. Figure 154 represents *Doryphora* 10-*lineata*. The larva is pale yellow, with a reddish tinge, and a lateral row of black dots.

I quote from Mr. Riley's report the following account of its habits. "In the latitude of St. Louis there are three broods during the year, the last brood wintering over in the beetle state under ground. They are usually dug up in the spring of the year in land that had been planted to potatoes the year before. The beetles issue of their own accord from the ground about the first of May, and the last brood of beetles enters the ground to hibernate during the month of October. Though in general terms this beetle may be said to be three-brooded, yet it may be found at almost any time of the year in all its different stages. This is owing to the fact that the female continues to deposit her eggs in patches from time to time, covering a period of about forty days; and also from the fact that among those larvæ which all batch out in one day, some will develop and become beetles a week and even ten days earlier than others. Thus it may be that some of the late individuals of the third brood pass the winter in the pupa state, though the normal habit is to first transform to beetles. Each female is capable of depositing upwards of a thousand eggs before she becomes barren, and in from thirty to forty days from the time they were deposited, they will have produced perfect beetles. These beetles are again capable of depositing eggs in about two weeks after issuing from the ground, and thus, in about fifty days after the egg is laid, the offspring begins to propagate."

This insect should not be confounded with a closely allied species (*D. juncta*, Fig. 153), which feeds upon the horse-nettle (*Solanum Carolinense*), a wild plant common in the southern and western states. It has not been known to attack the potato. This species differs from the other in

having the third and fourth stripe from the outside united, where they are distinct in the potato beetle, and the legs entirely pale yellow, with a dark spot on the thighs. The head of the larva, or grub, is paler than in that of the potato beetle.

A large number of parasitic and external insect-enemies prey upon the potato beetle, and were it not for these friends

FIG. 155.

Parasite of Potato Beetle.

of the farmer, he might well despair. The only insect as yet known to live parasitically on the potato beetle is the Lydella (Fig. 155, enlarged), described by Mr. Riley under the name

FIG. 156. FIG. 157. FIG. 158. FIG. 159.

3-banded Lady Bird. 9-spotted Lady Bird. *a* *b* *c* Hippodamia. Chilocorus.

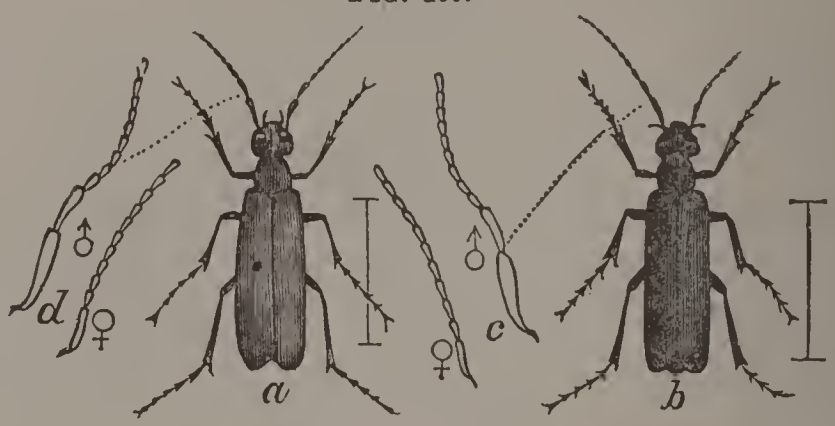
of *Lydella doryphoræ*. He remarks that "this fly destroyed fully ten per cent. of the second brood and fifty per cent. of the third brood of potato beetles that were in my garden."

Of the external enemies the lady birds are among the most efficient. (Fig. 156, *Coccinella trifasciata;* Fig. 157, *Coccinella* 9-*notata*, all slightly enlarged; Fig. 158, *Hippo-*

damia convergens; *a*, larva; *b*, pupa; *c*, beetle, natural size; and Fig. 159, *Chilocorus*.) These lady birds destroy the eggs and young grubs, and at times have been so efficient as to save to farmers a large proportion of their crops. On the opposite page are figures of different bugs and beetles which also prey upon the potato beetle, rendering the most efficient service. Of the bugs (Hemiptera) the first two figures* represent certain common forms said by Mr. Riley and others to prey at times voraciously both upon the larva and beetle itself; the remaining figures illustrate certain beetles known to prey upon it.

Some of the governments of Europe are taking measures to prevent this insect from crossing the Atlantic and invading the potato fields of the old world. The Swiss au-

FIG. 160.



Blister Beetles.

thorities are on the alert, and the Belgian government has promptly introduced a bill prohibiting the importation of potatoes from the United States and other countries, as a measure of precaution against the introduction of the Colorado beetle and spread of the potato disease.

The Blister beetles (Fig. 160, *a*, *Lytta cinerea;* *b*, *L. vittata*), which have at times ravaged potato fields, are said by Mr. Riley to devour the young of the Colorado potato beetle.

*Fig. 161, *b*, *Arma spinosa;* *a*, its beak, enlarged; *c*, the beak of *Euschistus punctipes*, a bug otherwise closely resembling Arma. Fig. 162, *Harpactor cinctus;* *b*, beak. Fig. 163, *Tetracha Virginica*. Fig. 164, *Calosoma calidum*. Fig. 165, *Pasimachus elongatus*. Fig. 166, *Harpalus caliginosus*. (See page 211.)

FIG. 161.

Arma.

FIG. 162.

Harpactor.

FIG. 163.

Tetracha.

FIG. 164.

Calosoma.

FIG. 165.

Pasimachus.

FIG. 166.

Harpalus.

Domestic fowl, as well as the quail and crow, and the toad and skunk, devour the grubs and beetles. The flesh of fowls which have eaten them, however, should not be placed upon the table, as the Colorado beetle is poisonous, and taints the flesh. Among the artificial remedies the use of Paris green, one part mixed with five of flour, and sprinkled over the plants dry, or the Paris green alone mixed with water is by far the better, and is now in universal use in the western states.

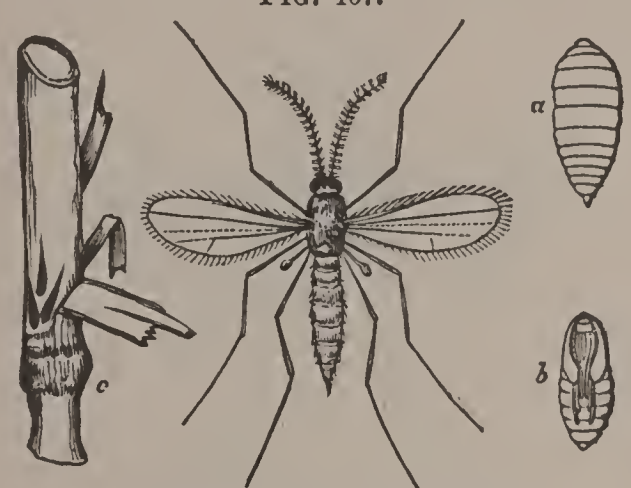
But however well Europe has succeeded in keeping American insect pests out of her borders, the easy-going, slack American farmer witnesses the arrival of European pests without let or hindrance. America is the land of the free, whether of those human pests who leave foreign countries for their country's good, or of their entomological prototypes. The same good-natured indifference and want of intelligent forethought, that let the Colorado beetle travel unimpeded from the Rocky Mountains to the Atlantic coast, looked with unconcern upon the importation of the European currant saw fly into this country, and beheld its rapid spread throughout the east and west.

We were less to blame for allowing the Hessian fly to get a foothold in our land. During the Revolutionary war, before we had gained a nationality, this midge was brought over in straw by the Hessian troops. As early as 1788, at least, this insect, or one exactly like it in habits, as shown by Dr. Harris, was known to be destructive in Switzerland. Harris states that it was "first observed in the year 1776 in the neighborhood of Sir William Howe's debarkation on Staten Island, and at Flat Bush, on the west end of Long Island. The history of its advance inland as given by Harris is a repetition of the mode of naturalization of the European cabbage butterfly and saw fly, known with certainty to be imported insects.

The Hessian fly (Fig. 167, *a*, larva; *b*, pupa) is about

half the size of the mosquito, but differs from it in wanting the long mouth-parts, while the antennæ are more hairy. It is black, with black wings, while the hind body is tawny and the legs are pale red, with black feet. The body is about a tenth of an inch in length, and the wings expand about a quarter of an inch. There are two broods, the flies appearing both in spring and autumn. At these times the fly lays from twenty to thirty eggs in a crease in the leaf of the young plant. Four days after, if the weather be favorable, the young, pale red maggots may be seen crawling down the leaf until, arriving at a joint in the stalk of the plant, they remain head downwards, as at figure 167, *c*,

FIG. 167.



Hessian Fly and young.

under the base of the leaf, where by the simple pressure of their bodies they become embedded in the side of the stem. Two or three maggots thus embedded are sufficient to cause the plant to wither and die. In five or six weeks they mature, and by the first of December their skin hardens and becomes of a chestnut-brown color. This is the so-called "flax-seed" state. The outer larval skin encases the larva, or maggot, whose body is contracted and somewhat changed in form. In this state it remains through the winter. Towards the end of April or early in May, the pupa becomes perfected and by the middle of May in New England escapes from the

pupa-case in which it has been wrapped like a mummy. This occurs just as the wheat is coming up. For a period extending over three weeks they lay their eggs and then disappear. The maggots hatched by the eggs laid by the spring brood assume the flax-seed form in June and July, and are found unchanged in the autumn, most of them remaining in the stubble. This is a most important fact, of which the farmer may take advantage. Now, if the stubble be burned in the autumn, millions of these maggots will be destroyed, and if this process were carried on in every wheat field in the country the ravages of this and other destructive insects would be stayed. As it is now we are almost wholly

FIG. 168.

Parasite of Hessian Fly.

dependent on nature's means of preventing their too great increase. Figure 168 shows (much enlarged) a parasitic four-winged Chalcid fly, which has the instinct to thrust its ovipositor through the sheath of the leaf under which the maggot of the Hessian fly lurks, and deposit an egg in its body. Dr. Fitch has suggested that the European parasite of this and the wheat midge should be imported and bred by the quantity, so as to stop their ravages. It would be a simple thing to do. A quantity of stubble from an English or French wheat field could be imported and scattered over the wheat fields of southern New England and the Middle

States, and in this way the parasites with but slight expense be had by the quantity. Why have not commissioners before this been appointed by the several state authorities to attend to this important matter?

While the Hessian fly attacks the root, the wheat midge adopts the ear as its point of attack. When the wheat is in blossom the females lay their eggs in the evening in clusters of from two to twenty, by means of the long, retractile, tube-like extremity of the body, within the chaffy scales of the flowers. The orange-colored maggots appear in from eight to ten days after, and when fully grown are one-eighth of an inch long. They crowd around the germ of the wheat,

FIG. 169.

Parasite of the Wheat Midge.

which by pressure becomes shrivelled and aborted. About the first of August it casts the skin, either while in the ear or after it has descended to the ground. After descending to the earth it spins an earthen cocoon, smaller than a mustard seed, and remains through the winter about an inch under ground. The midge appears the next June and July. Figure 169 represents its most deadly parasite. In dealing with this midge it is obvious that if the wheat field is ploughed after the stubble is burnt off, either in the autumn or spring, great numbers will be cut off, for when buried five or six inches, the fly is unable to reach the surface of the ground. Another method is to sow grain late in the season,

for example, in New England after the 15th or 20th of May. By early sowing the young wheat will have got the start of the flies, and too large and strong for them to kill it.

For a third and often still more destructive insect, which sometimes succeeds in cutting off a half and sometimes nearly the whole of a crop of wheat, oats or barley, we must turn to the very family of parasitic chalcid flies which are as a rule beneficial to agriculture. A few of them make galls in the stems of plants, and the maggots, instead of feeding on the juices of living insects which serve as their hosts, prey on the juices of plants. Such is the famous joint worm or *Eurytoma hordei*. This is a native insect. It is a little, shining, black, four-winged fly, a little over a line in length, with the knees and feet pale yellow. The hind body is attached by a slender pedicel to the thorax, and the male antennæ are provided with tufts or verticils of fine hairs.

When the wheat or barley is about eight or ten inches high, their growth is often checked, the leaves turn yellow, and irregular gall-like swellings arise between the second and third joints of the stalk, or in the joint itself. In November, in New England, the worms transform into the pupa state, living through the winter unchanged in the straw, or remaining in the stubble in the field. In Virginia, where the joint worm has been fearfully destructive, the maggot does not transform until late in February, or early in March. From early in May until the first week in July the flies issue from the galls in the dry stubble and are supposed to immediately lay their eggs in the stalks of the young wheat or barley plants.

From a knowledge of the habits of this insect it is evident that the prudent farmer by coöperating with his neighbors can successfully cope with this insect if he and they are careful to burn the stubble in the autumn and spring, and carry on the process for several successive years over a large

tract of country. Ploughing in the stubble in this case does not injure the insects, as with their hard bodies they can work their way out of the earth. The joint worm has several parasites, members of its own family, and it must be a pleasant sight to the agriculturist, however it may strike the moralist, to see the members of this large family falling upon and destroying one another, and in such an atrocious way, too. Indeed, our sole dependence for protection against noxious insects is the literally intestinal wars by which their numbers are kept down to a moderate figure.

The Army worm of the north is essentially a field insect. It is not usually a common object, but at long intervals it swarms in immense numbers, cutting off acres of wheat, barley, oats and grass. This worm is the caterpillar of the *Leucania unipuncta*, one of the family of night-flying moths, represented by the cut worms (Agrotis, see Figs. 9, 10, 11) and Cucullia, etc. The present moth is rusty grayish ochreous brown, with the wings free from the usual markings, and only a few dark dots forming a row parallel to the outer edge of the wing, with a single white dot near the centre of the wing. She probably lays her eggs near the roots of grasses, such as the timothy and red top, about the middle of June. In the Middle and Western States the eggs are probably laid in April and May, and the moths lay their eggs for a second brood in June and July, while in New England the moth appears in October, and probably then lays eggs which do not hatch till the spring.

The caterpillars on hatching feed for about four weeks, until nearly fully fed, when they stray off to seek fresh pastures. Usually their numbers are inconsiderable, but several times during the last and the present century they have appeared in immense armies. In New York and New England they have occurred in great numbers in 1743, 1770, 1790 and 1817. In southern Illinois they abounded in 1818 or 1820. In 1842 they were very destructive. In 1856 they

appeared in such numbers as to attract general attention, but in 1861, the year in which the writer first made their acquaintance, they were a grievous plague.

A writer in Danvers, Mass., says: "They were seen in great numbers through the entire field of several acres, climbing up the stalks of the barley, eating the blades and cutting off the heads of the grain. The day after these worms were discovered, the barley was mowed in order to preserve it, when they dropped to the ground, throwing themselves into a coil, a habit of the insect when disturbed. Many of them soon commenced a march for the neighboring fields and gardens, while others blindly pushed forward a column across the highways over a stone wall, where they were crushed by travellers on the road. But the main body marched to the adjoining gardens and enclosures, where the proprietors were waiting to receive them in their entrenchments, which had been thrown up a foot wide and two feet deep. The worms, as they fell in their advance into the trenches, were assailed in various ways by eager combatants, some spreading over them lime, tar or ashes, while others resorted vigorously to pounding them. In this way, countless numbers of them were destroyed. The rear guard, composed principally of those of smaller growth, kept in the field, where they were picked up by a troop of fifty young red-winged black-birds. I also noticed the robins feeding on these vermin." Again: "In adjoining lots they were commencing their devastation upon the corn, turnips, cabbages, weeds and grass. They leave the grass ground completely clean and white, so that it has the appearance of having been scorched in the sun. The cabbage and turnips they destroy by eating the tender parts of the plants, while they attack the corn by descending the spindle and concealing themselves in large numbers among the leaves where the corn is to make its appearance. Corn thus attacked looks wilted and drooping. In some hills, the stalks were stripped

of all their leaves. There were no worms upon the potato tops, though they have killed all the grass to the borders of the field."

The name "Army worm" is suggestive of the regular, trained way in which myriads of these caterpillars march together in long, deep columns, side by side, steadily over every obstacle, wherever their food or instinct may lead them. Unlike the cut worms, which move by night, singly, from field to field, and secrete themselves by daytime at the roots of the plants they attack, the Army worm feeds in the forenoon as well as the evening. They may be seen scattered over fields of grain or grass, either devouring the leaves or cutting off the heads and letting them fall on the ground. They will thus eat their way across a field, wantonly mowing off the heads of the grain. In this way in Plymouth county, Mass., they destroyed an acre and a half of wheat in one night, and then attacked a corn field in the same ruthless manner.

This caterpillar appears first in July in Massachusetts, and a month later in Maine, where we saw it at Bangor and northward between the first and middle of August.

It is about an inch and a half long, like the cut worm in shape. It is dark, with a light, interrupted, thread-like line along the middle of the back; on the sides a light line edged with two thread-like lines, and a light colored, waved line just above the legs.

About the middle of August it descends into the earth, and there constructs a rough earthen cocoon, or contents itself with making a rude cell of dry grass just below the surface, in a day or two after assuming the chrysalis state. Lying here for ten days or a fortnight, the moth flies about at the end of August.

In dealing with this insect, the best remedy is of a preventive nature. If the grass lands and wheat fields are burnt over in autumn multitudes of the moths, or chrysal-

ides will be destroyed. The natural enemies are birds and ground beetles which collect about the rear and van of the moving army. Six species of ichneumon flies prey upon them, among which is a kind of Ophion (Fig. 170). These parasites either attach an egg to the outside of the body of the caterpillar, or insert it beneath the skin. Mr. Walsh, who discovered most of these parasites, also found that a Tachina fly, an insect somewhat like the ordinary house fly, was in Illinois so destructive that out of nearly sixty worms all but two had the eggs of these flies stuck in groups of

FIG. 170.

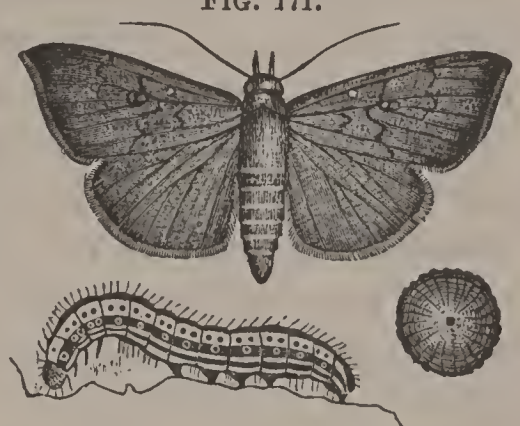
Parasite of the Army Worm.

from one to six on the upper side of the body. From these caterpillars he bred fifty-four Tachinas and only two moths. Such is the effective warfare waged upon one insect by another. In this way the balance of nature is preserved. As to their mode of attack he states that "Jefferson Russell, an intelligent farmer, had repeatedly, on damp cloudy mornnings, watched a large bluish green fly, about the size of a blow-fly, attacking the army worm, and depositing its eggs on the shoulders of the victim, as he ascertained by a

double lens. As they were attacked, the army worms kept dropping to the ground and gathering in clusters, or hiding under clods, until finally the wheat on which they occurred was entirely free from them."

The Army worm of the south, or cotton worm, is quite a different sort of caterpillar from its northern namesake. It loops in its gait, and may thus be distinguished from the boll worm, also found upon the cotton. Its body (Fig. 171, moth and larva, natural size; egg, much enlarged) is rather thick in the middle, tapering towards both ends; and it is green, covered with short hairs, and dotted with black along a yellowish line situated on each side of the back, and with black dots beneath. The moth is reddish brown, the wings quite free from the markings usual in the group to which it belongs; the fore wings are triangular, with two indistinct, dark, zig-zag lines, with a conspicuous dark spot near the centre of the wing, in the middle of which are two white dots.

FIG. 171.



Cotton Worm, egg and moth.

She lays from four to six hundred low, flattened, greenish eggs, ornamented with vertical ribs, placing them upon the under side of the leaf. In from two to ten days the young worms hatch, and begin to feed on the pulpy portion of the leaf, but as they grow larger they devour the entire leaf as well as the buds and blossoms. During their life as caterpillars, which only lasts from fifteen to twenty days, they cast their skins five times. As regards the habits of the cotton worm I cannot do better than to quote from Mr. Riley's second Report on the Noxious Insects of Missouri, in which he says that "there are three different broods of worms during the year, the first appearing in June or July, and the last, which does the most damage, appearing in

August or September, or even later. Mr. Lyman, in the little work already referred to, says: "That nature has made no provisions by which either the fly, the worm, the chrysalis or the eggs, can survive the winter or exist for any length of time where the cotton plant is not a perennial." But this is surely an error, which Mr. Lyman would never have made, had he possessed a better knowledge of insect life; and as Mr. Glover found that the chrysalis was killed by the slightest frost, the insect evidently winters over in the moth state, as do many others belonging to the same tribe. Mr. W. B. Seabrook gives strong evidence that this is the case, in a "Memoir on the Cotton Plant," read in 1843, before the State Agricultural Society of South Carolina, wherein he says: "That the Cotton Moth survives the winter is nearly certain. An examination of the neighboring woods, especially after a mild winter, has often been successfully made for that purpose." And Dr. Phares states positively that "the moth hibernates in piles of cotton seed under shelter, under bark and in crevices of trees in dense forests and other secluded places, and that it may often be seen on pleasant days in winter."

While this worm is young and small it does not seem to attract attention, but early in the autumn it suddenly becomes abundant, and at certain years extremely destructive. One of these visitations, which fell under the observation of the eminent botanist, Professor J. Darby, of Auburn, Alabama, is thus described in a letter to the writer: "Saturday, September 19th, I was in the field examining the forms (buds before flowering) and the young bolls (fruit after the floral organs have fallen off). I examined all carefully, with no signs of eggs or worms. On Sunday I did not see it. On Monday I passed it as usual and observed nothing unusual. On Tuesday morning I passed it and noticed nothing unusual. On Tuesday noon every plant in the field was stripped of all its upper leaves; not one remaining as

far as could be seen, and the plants were covered with millions of worms. I counted on one plant forty-six worms. They commence at the top of the plant, eating every leaf. When the leaves were gone they attacked the young bolls, eating through the perianth and consuming the young cotton. In the course of four days the work was done. They did not touch the grape or any other plant in the field, so far as I have been able to see. Many left the field, and thousands were in the road and on the fences, but not one in a thousand thus escaped. To-day, September 23d, there is scarcely one to be seen. Their disappearance is as mysterious as their coming. They have left no signs that I can see, either on the stalks or in the ground. They have extended over hundreds of miles, and nothing has proved a barrier to them, having been as destructive on islands in the river, as elsewhere. One-third of the cotton crop has been destroyed. Nothing of the kind has occurred in thirty years past to my knowledge."

After the caterpillar has become fully grown, it draws a leaf around it, and then changes to a chrysalis. It remains in this state for one or two weeks, when the moth escapes.

In dealing with this insect, the only practicable way to diminish its powers of doing mischief is for all the cotton planters to combine and employ hand-picking, looking over the leaves for the eggs when the moths lay them, and again picking off the worms when they are detected. The use of carbolic acid, cresylic soap-suds and other washes have been recommended.

This insect seems to appear wherever cotton is raised. It is very destructive in the West Indies and in South America, and either this or a similar insect occurs in Egypt. It is also sometimes found in New York, and I have taken several specimens late in the summer on an island in Salem harbor, Massachusetts. Mr. Grote thinks that away from the Gulf States the whole brood dies every year, and that

the caterpillars of the next summer come from eggs laid by moths which have flown north from the Gulf States. This is not, however, in accordance with the habits of moths generally, and we shall expect to find that the moth winters over in the middle and northern states, where it is a straggler, as well as in the southern states. It will be interesting to know on what plant the caterpillar feeds north of the cotton states.

The boll worm (Fig. 172, moth and larva) is more like the cut worm in appearance. It feeds on the boll of the cotton plant, the moth laying her eggs singly up to the num-

FIG. 172.

Boll Worm and Larva.

ber of five hundred on the calyx of the plant. The caterpillars appear in three or four days. They pierce through the calyx and destroy the flower buds. When fully fed it makes an oval cocoon just under the surface of the soil, where it remains in the pupa state three or four weeks. There are two broods of this worm in the Middle States, three in Georgia. The last brood issue as moths in November, though, unlike the Army worm, some remain under ground through the winter.

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